POLARIMETRIC REMOTE SENSING OF OCEAN SURFACE WINDS

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There has been an increasing interest in the applications of polarimetric microwave radiometers for ocean wind vector remote sensing. This paper presents a comparison of microwave radar and polarimetric radiometer signatures of sea surfaces using a combined analysis of experimental observations and theoretical modeling. The experimental data were acquired from a series of aircraft flights from 1994 through 1997 by the Jet Propulsion Laboratory (JPL) using the JPL 17, 19 and 37 GHz polarimetric radiometers (WINDRAD) and Ku-band dual-polarized scatterometer (NUSCAT). Fourier analysis of the data versus wind direction was carried out and the coefficients of Fourier series are illustrated against the wind speed at 45, 55, and 65 degree incidence angles. There is a good agreement between the JPL aircraft flight data and Wentz's SSM/I geophysical model function for the vertically polarized brightness temperatures, but Wentz's SSM/I wind direction model for horizontal polarization shows a significantly stronger upwind and downwind asymmetry than the aircraft flight data. Comparison of the dual-frequency WINDRAD data shows that the wind direction signals are similar at 19 and 37 GHz, although the 37 GHz data have slightly stronger signals than the 19 GHz data. In general, the azimuthal variations of brightness temperatures increase with increasing wind speed from low to moderate winds, then level off and decrease at high winds. The only exception is the U measurements at 65 degree incidence angle, which have a stronger than expected signal at low winds. An exponential function was proposed to model the sensitivities of wind direction signals to wind speeds. The wind direction model is augmented with a theoretical analysis of wind speed sensitivities of brightness temperatures using a theoretical scattering model to obtain a geophysical model function at 45 to 65 degree incidence angles. The sensitivities of ocean brightness temperatures to wind speed and wind direction are compared with the NUSCAT Ku-band ocean backscatter from 3 to 35 m/s. There is a strong correlation between the coincidental active and passive microwave signatures. This suggests the significant contribution of short ocean waves to passive ocean emissivities. A simulation of spaceborne polarimetric radiometer and scatterometer was carried out with the semi-empirical WINDRAD geophysical model function and the NSCAT/NUSCAT geophysical model function. The simulation suggests that passive microwave radiometers have a better wind speed and direction accuracy than scatterometers at moderate and high wind speeds for non-precipitation conditions, while scatterometers are more accurate for low to moderate wind speeds and more robust to weather conditions.